MADROÑO, Vol. 54, No. 4, pp. 354–365, 2007

REVIEWS

Fire in California's Ecosystems. Edited by NEIL G. SUGIHARA, JAN W. VAN WAGTENDONK, KEVIN E. SHAFFER, JOANN FITES KAUFMAN and ANDREA E. THODE. University of California Press. Berkeley, CA. 612 pp. $75.00. ISBN-13 948-0-520-24605-8.

Plant biologists in California have long-recognized the important effects of fire on the state's vegetation and flora (e.g., Brandegee 1891), and will appreciate a book covering this topic. We are, however, only one of the audiences for this new book. Interest in fire has proliferated across disciplines, and in policy and management arenas. It is difficult to capture a topic as multi-disciplinary and complex as fire in California ecosystems and the management issues it creates, even in a large book such as this. Yet the book does aim to be a complete reference on these subjects. The authors and editors are to be commended for putting together a large volume of information in pursuit of an ambitious goal, and producing an attractive, well-illustrated textbook. This book has many voices: five editor/authors and 45 total authors. Most (24) are from large land management agencies, primarily the U.S. Forest Service. The book is dedicated to Harold Biswell, best known for his devotion to managing wildlands using fire.

Fire in California's Ecosystems is divided into three sections. The first is an introduction to fire ecology. The second describes fire history and ecology in nine bioregions in California. The third section is about fire management. The book includes a short glossary. (This glossary does not include some undefined terms used in the book that are technical [e.g., pyrolysis], or potentially ambiguous [wildland-urban interface].) There is also a useful appendix with an explanation of plant alliances and species characterizing California's bioregions. Special topics are included as short, but interesting sidebars throughout the book. Below, I critically evaluate material from each section most relevant to plant biology for completeness, accuracy and consistency.

Section I: Introduction to Fire Ecology—There are chapters on fire as a physical process, how fire is affected by weather and climate, and how soil, water, air, plants, and animals are affected by fire. These chapters provide the reader with a primer on fire behavior and ecology. Chapters vary in their level of detail, with the one on fire and animal interactions being longest. The chapter on fire as a physical process is an informative summary of an often poorly understood topic. For example, it is often presumed that fire spread is governed by fuel load, but this chapter explains how rate of fire spread and fuel load tend to be inversely correlated because fuel and biomass are heat sinks and can decrease wind. The subject of fire behavior could have been more detailed, however, to allow better explanation of some concepts, for example that ladder fuels "allow" a fire to reach the canopy of a forest. If overstory tree crowns are sufficiently heated from below (a function of windspeed and interrelated surface fire intensity) they can easily bridge a considerable fuel gap and burst into flame. This is not clear, and the reader may conclude incorrectly from the description of canopy fuels that fire must climb a hypothetical ladder to effect crown fire. There is also ambiguity about foliage density needed to propagate fire vertically (which will depend on its chemical energy) and whether shrubs are ladders (apparently no in Section I and yes in Section III). Thus, it is not clear what constitutes a "ladder" fuel. In addition, crown fire requirements are supposed to be modeled based on live foliage, not other canopy biomass, an important distinction (Cruz et al. 2004) that is not conveyed. To explain crown fire initiation, the first phase of combustion, preheating and the thermal degradation (pyrolysis) of solid fuel to the gaseous phase, could have been examined more with respect to chemical properties and energy content of foliage that support ready ignition of tree and shrub crowns exposed to heat (e.g., waxes, oils, and volatiles that vaporize at low temperatures).

I was surprised to read in the first section that the editors do not recognize fire as an ecological disturbance. The ecological literature defines any event that causes sudden mortality or a reduction in biomass, as well as an increase in resource availability, as a disturbance. Fire is a classic natural disturbance. The basis for understanding vegetation change and secondary succession is the character of disturbances, and the legacies left behind, such as surviving organisms, seeds, spores, soil, dead trees, logs, and other biomass (White and Jentsch 2001). Natural disturbances are vital to biodiversity (Petraitis et al. 1989), and their effects in disrupting equilibrium and competitive exclusion and in creating spatial and temporal environmental heterogeneity, are key for understanding the complexity of nature. In addition, a key for understanding when degradation of natural systems will occur is the occurrence of novel or compounded disturbances (Paine et al. 1998). By describing fire as distinct from disturbance, the reader may be directed

away from one of the most important, extensively studied topics in ecology that provides a foundation to understand the effects of both fire and fire management disturbances.

Additional problems in the introductory section include a table on plant adaptations that appears to indicate that *Ceanothus megacarpus* is serotinous, an extreme fire-specialization where seeds are stored in fruiting structures that open to release them after being heated by fire. This would be quite significant if true because only gymnosperms are serotinous in the Northern Hemisphere. The introductory section also mentions that serotiny occurs in lodgepole pine in California. However, this applies only to the subspecies of lodgepole found in the Rocky Mountains, unless there has been a new discovery (no citation is given). Chamise chaparral is used as an example of a community with very low post-fire plant diversity, but this is an especially poor choice because chaparral dominated by chamise can be very diverse after fire, as described in Section II. Similarly, a section on spatial patterns of fire severity uses chamise chaparral as an example of where fire severity will be homogeneous, but this chaparral has been found to have pronounced local gradients and spatial complexity in fire effects as described elsewhere in Section I. However, the strong patterns are not caused by dead branches on the ground as described, but the collapse of live shrub crowns during fire. Finally, a sidebar describes fire in southern California chaparral as a strongly age-dependent process, but does not refer to literature presented in Section II illustrating that fires have instead been found to sweep through young and old stands with similar probability. As with other cases where the book presents conflicting information in different sections, there is not an attempt to reconcile or cross reference competing treatments so that the reader may be aware of them.

Section II: The History and Ecology of Fire in California's Bioregions—There are separate chapters on each of the nine bioregions into which California is divided. These chapters provide nice summaries on the climate and geography of the bioregions. There are also overviews on the historic occurrence of fire, separated into presettlement (prehistoric), post-settlement (historic), and current time periods. This illustrates how fire regimes have changed continuously in the past due to climatic and cultural influences. Interactions between fire regime and plant communities are described separately for ecological zones within each bioregion. Plant biologists in particular will want to refer to the informative appendix listing plant alliances and species characterizing ecological zones within each bioregion. In some chapters, there are sections on fire-specialized vegetation, such as serotinous

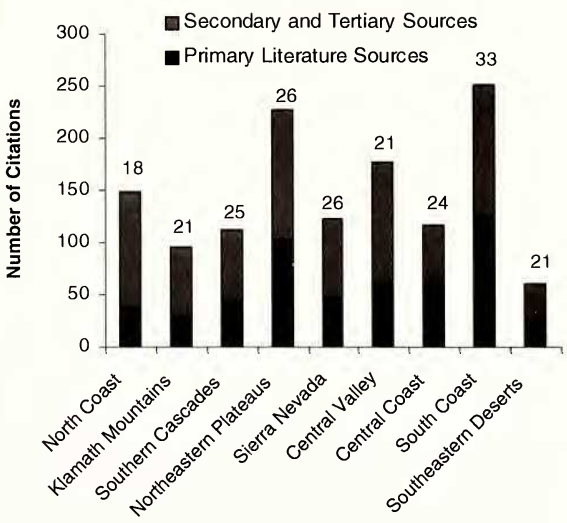

FIG. 1. Primary and secondary and tertiary information sources cited in bioregional chapters of *Fire in California's Ecosystems*. The numbers above the bars are the pages of narrative in each chapter.

pines, which are particularly interesting. Each bioregional chapter concludes with a section on management issues. Management is also addressed in most of Section III. It would have been more efficient to locate all the management text together there. This would have helped reduce inconsistencies described below, and allowed for more complete coverage of other topics by bioregion.

To help compare completeness of regional treatments, I charted the number of primary and other literature citations in each chapter in Section II (Fig. 1). The large disparity in citations in part reflects differences in the amount of research conducted in different regions. For example, comparatively little research on fire has been done in the Mojave and Sonoran Desert regions of California, where fire was very rare prior to the recent spread of exotic grasses. In the South and Central Coast bioregions, there has been relatively little fire history work to cite. Conversely, numerous studies on fire history are cited in chapters on forested bioregions. These chapters could have been more complete by discussing and citing more ecological literature. Interesting research could have been cited in many of these chapters on subjects such as the reproduction of non-serotinous conifers following crown fires and survival of seeds in their cones, postfire growth and dynamics of these conifers and how this can be facilitated by mycorrhizal fungi shared with *Arctostaphylos* and *Arbutus*, fire severity patterns in conifer forests, and fire and forest disease and insect interactions. In addition, there are non-forest vegetation types that are widespread, but not mentioned in some bioregions, such as chaparral

in the North Coast bioregion. This is being replaced by Douglas-fir in the absence of fire. This is a key biodiversity concern on National Park lands.

Also omitted is any explanation or citation of literature on the limitations of fire scar methods for describing fire regimes. Existing literature describes how opportunistic sampling and data aggregation, can significantly underestimate the spatial and temporal variability in fire that occurred across landscapes in recent centuries. This subject is noted in the climate and weather chapter in Section I, which explains how a fundamental property of all fire regimes is that large fires account for the majority of cumulative area burned, but fire scars provide mainly a record of fires in the past that spread very little before going out. This is not only a problem for estimating past fire size, but also behavior, because large fires often burn under conditions ranging from extreme to very mild. The omission of key literature for understanding past fire regimes in California is not consistent with the intent of the book to be a complete reference.

Section III: Fire Management Issues in California—There are 8 chapters addressing topics ranging from Native American fire use, to current fire management, and effects of fire on air resources. There are also chapters on fire and exotic and at-risk species. Much interesting information is summarized. However, there are also notable omissions, and areas of inconsistency with other portions of the book. Most of these are in the chapter on current fire and fuel management. This subject has important implications for vegetation and flora, and thus will be the focus here.

In contrast with earlier portions of the book describing wildfire as a vital ecosystem process, it is viewed mainly as a destructive agent in the assessment of current management. Given the history of homes burning in wildfires in California, it is understandable for managers to view fire in this light. However, the loss of homes in California can also be recognized as a planning problem (Halsey 2005), and a particularly relevant omission in a book covering fire management issues in California is the literature on the cause of home ignitions during wildfires and how to prevent them. This subject is not as intuitive as it may seem. As described in a number of publications by structure ignition specialist, Jack Cohen, who has investigated the cause of home loss associated with wildfires throughout the western United States, these ignitions can occur during low intensity ground fires, without the vegetation adjacent to the home burning, and well inside the perimeter of communities, not just at the urban interface. A primary cause of ignitions is long-distance embers. Even where wildfire extent has already been reduced to historic lows by fire suppression, home ignitions are increasing. Wildlands will continue to burn and produce long-distance embers regardless of management. The only way home ignitions can be effectively eliminated is by treating the home and its immediate surroundings (Cohen 2000). This is an important lesson that managers and policy makers still fail to grasp, which the book could have addressed. An unfortunate consequence of current management approaches that continue to look to fire prevention in wildlands to protect homes has been complacency about fire planning and incentive for more unsafe development in fire prone ecosystems (Kennedy 2006). The pressure for such development and the need to justify enormous fire prevention expenditures in turn creates incentives to promote the viability of fire prevention approaches in wildlands. Fire behavior may then tend to be viewed too much as a function of management, especially effects of fire prevention, instead of climate, weather and topography. In chaparral, assumptions that fire is preventable and not largely weather-driven are especially unrealistic, as described in Section II but not in the management section. The treatment of current fire management issues does not take a hard look at the potential effectiveness of treatments in wildlands, nor explain the need to make the specific actions that will prevent home ignition, the first and foremost management priority.

Ironically, the justification presented for continuing to invest limited resources heavily in fire prevention approaches in wildlands is that this is needed to combat uncharacteristically large and severe fires caused by the effects of... fire prevention. However, where most of the state's largest fires are occurring, in southern California chaparral, fire prevention has not been successful. Instead, the opposite situation, more frequent fire, has been occurring. This is due largely to human ignitions and grass invasion, as explained in Section II. Moreover, large fires have always characterized this vegetation, and the probability of these has not changed. Conversely, where fire has been prevented, in forested regions, as described in Section II, this has not lead to an increasing trend in wildfire activity (Fig. 2). Section II explains how current rates of burning are a fraction of those in the past, when fires were not only frequent, but also included a range of severity. In addition, chaparral has been replaced by forests, which support much less crown fire. Thus, both amounts of fire and area affected by high severity fire appear to have been decreased overall where fire prevention has been effective. Where fire severity has been increased, this may be traced to the effects of silvicutural activities (Weatherspoon and Skinner 1995).

The chapter on current management, in explaining the case for large investments in

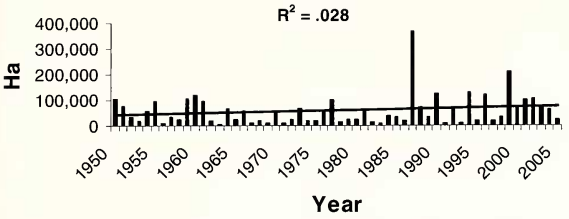

FIG. 2. Annual area burned from 1950 to 2005 in bioregions of northern California in which fire occurs predominantly in forest. Bioregions are the Bay Area, Klamath, Modoc (includes S. Cascades), and Sierra Nevada. Bioregions and fire perimeter data from the California Department of Forestry and Fire Protection, available with metadata at: http://frap.cdf.ca.gov/index.htm.

wildlands treatments to combat an emergency due to effects of fire prevention, equates fuel with biomass. As defined in the glossary and Chapter I, however, fuel is specifically the biomass that feeds combustion. Forest biomass increases as trees grow, but commonly stabilizes. So do the fuels that influence fire behavior: ground, and especially foliar fuel. Equilibrium fuel depths in California forest floors were previously described in California forests by renowned soil scientist Hans Jenny and others at Berkeley (e.g., Kittredge 1955). Although the chapter on current management says that fuel is accumulating "far beyond natural levels," a sidebar presents conflicting data showing surface fuel approaching, after only 10 yr following fire, levels that occurred with over a century of fire exclusion. In terms of foliage amounts, ecophysiological literature describes how a proxy for this, leaf area, also reaches a maximum in forests early in succession. Fire severity can also decrease with increasing biomass as forests replace chaparral, as they have in many areas. While biomass today may exceed "natural" levels the potential for vegetation to burn has always been high. What is clearly different today are extensive urban and intermix fuels prone to ignition.

Emergency fire management that is based on "preventing fire and reducing its effects" by treating biomass in wildlands, the focus of the management chapter, can be counter to safety and restoration needs. Investing heavily in fire prevention and extensive treatments in wildlands can divert limited resources and attention away from the highest safety priority, the home ignition zone. The massive expenditures for fire prevention efforts and incentives to continue them and promote their effectiveness can indirectly subsidize poor planning that undermines safety (Kennedy 2006). Where restoration is needed due to lack of fire, preventing fire increases the problems created by fire prevention. Thinning or other partial harvesting and mastication places biomass on the ground, where it is converted to fuel, increasing potential fire effects. The resulting increased solar radiation and decreased wind resistance due to tree removal can promote more rapid spread and intensity of wildfires, as described in Section I. Although these mechanical treatments and grazing are referred to as restoration in the chapter on current management, they do not have the unique effects of fire described in Sections I and II that are needed for restoration. The treatments have the additional drawback of introducing novel and compounded disturbances and exotic species. However, while fire itself is needed for restoration in many areas, the recommendation to expand prescribed burning programs in chaparral is not a logical response to a problem of excess fire and could work against restoration by causing further grass invasion. Grazing treatments in chaparral and desert regions may also increase non-native grasses that cause excess fire there.

Where fire has been excluded, only treatments involving fire can be effective at both reducing available fuel and restoring fire. However, due to safety and air quality concerns, as described in Section III, prescribed burning is far too limited in extent to return past amounts of fire. Moreover, even prescribed fire may not effectively reduce fuel or replicate past fire if too subdued, small in area, or if done during the off-season, when effects on fuel, soils, breeding species and exotics may be undesirable. Where thinning or mastication slash is burned, effects on soils and atmospheric emissions can be increased. Ironically, the large fires that are considered disasters from a management perspective avoid these concerns and accomplish most fuel reduction and ecological restoration where fire is needed. However, if fire and its beneficial effects are to be truly accomodated and restored where they have been excluded, a strategy that prioritizes specific actions required to prevent home ignitions is needed.

Although a considerable part of the book is devoted to management issues, there are a number that are overlooked in Section III. An assessment of the practice of "salvage logging," perhaps the most controversial fire management practice today, is a particularly noteworthy omission, especially considering recent literature on the subject. Although managers cite restoration and fuel reduction goals in promoting this treatment, large quantities of biomass are relocated to the ground and converted to fuel, and reproduction by conifers and other species is inhibited. There are also concerns over the need to protect rather than cut burned forest habitat, which supports unique species assemblages and vegetation renewal processes. This habitat has become rare with fire exclusion. The effects of a controversial management practice, post-fire seeding, are nicely described in a separate sidebar

in the chapter on fire and aquatic and watershed resources. This example could have been followed in describing collateral damage from commercial logging and grazing treatments done in the name of fire managment.

Conclusions

The topic of fire in California ecosystems is complex and multidisciplinary, and very difficult to encompass in one book. *Fire in California's Ecosystems* summarizes well much of the relevant literature. However, there are important topics that are omitted or not adequately addressed with up-to-date perspectives. Other literature can fill these gaps. Bond and van Wilgen's 1996 short classic, *Fire and Plants*, better addresses fire as an ecological and evolutionary force and recognize it as a natural disturbance process. These are important perspectives for understanding fire, particularly as it affects plant biology and biodiversity. Perspectives that do not shy away from critically analyzing existing land management and planning, and that more broadly consider solutions to today's wildfire problems are also important to consider. In addition to the aforementioned books by Halsey (2005) and Kennedy (2006), a good accompaniment to *Fire in California's Ecosystems* is the recently published book *Wildfire: a Century of Failed Forest Policy*, edited by Wuerthner (2006). As these books point out, incentives created by huge fire budgets and commercial activities discourage pursuit of specific actions needed for protecting human communities from fire and restoring fire regimes in plant communities. These are particularly important needs in California.

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Fire in California's Ecosystems. Edited by Neil G. Sugihara, Jan W. van Wagtendonk, Kevin E. Shaffer, Joann Fites Kaufman and Andrea E. Thode. University of California Press. Berkeley, CA. 612 pp. $75.00. ISBN-13 948-0-520-24605-8.

CALIFORNIA'S FIRE ECOLOGY: A NEW SYNTHESIS

In the foreword to *Fire in California's Ecosystems* Jim Agee predicts: "The volume you hold now will become the secular bible of fire ecology for Californians." Dr. Agee's statement implies that the reader need look no further to satisfy his/her questions regarding ecology and management of fire in the nation's third-largest state. *Fire in California's Ecosystems* is a comprehensive synthesis of the current state of knowledge for fire ecology and management in California's diverse ecosystems.

The book is organized in three parts, including a first section on basic fire ecology, followed by a collection of chapters describing fire ecology and management for each of nine bioregions, culminating in a collection of eight chapters geared towards over-arching fire management issues. *Fire in California's Ecosystems* is very well put together for a collection of contributed chapters. The editing is polished and the authors have followed a common organizational template. Sidebars are generally very useful and cover topical features such as fire climate, landscape dynamics of chaparral communities, plant adaptations to fire, and exotic annual grasses, to name only a few. Illustrations and GIS maps are clear, consistent among chapters, and professionally formatted. Copies and scans of many of these illustrations are sure to appear

in numerous lectures on fire ecology and forest management.

The first seven chapters would be valuable reading for any fire ecology course, anywhere in the world. Each of these chapters is clear and comprehensive. Taken together they provide a solid overview of fire as an ecological disturbance. Chapters cover the basic concepts of fire ecology with regard to weather and climate, fire physics, fire regimes and plant community dynamics, fire effects on the environment, fire effects on plants, and fire effects on animals. Unfortunately, the coverage of ecosystem effects of fire is relatively limited. The "physical environment" effects of fire (soil, water, air) are covered in just one chapter (Chapter 5). This chapter is well-presented, but this is a huge area of study and the book might have been better served as a core fire ecology text if the air, soil and biogeochemistry, and water effects had been broken out into separate chapters. Also, this chapter omits discussion of fire regime change (e.g., fire exclusion effects). Chapter 6 on *Fire and Plant Interactions*, contributed by Joann Fites-Kaufman and coauthors, includes an informative discussion of plant adaptations and fire effects across several levels of ecological organization. Jon Keeley has contributed a thoughtful sidebar on the evolution of fire adaptations.

The nine bioregional chapters (Part II of the book) are organized consistently according to subdivisions of ecological zones, and vegetation alliances within ecological zones. Each of these chapters includes a general description of the physical environment, an overview of fire history, a description of major ecological zones including fire ecology and interactions between the fire regime and plant communities, and contemporary management issues. Included in each chapter are tables summarizing life history adaptations to fire for key plant species within each bioregion, as well as summary tables describing fire regime parameters (fire seasonality, return interval, extent, severity, etc.) for each vegetation type. Such organizational consistency is impressive and doubtless reflects strong-willed editorship as well as substantial commitment on the part of the authors. A high level of organization is needed to create a coherent picture of such diverse fire environments and ecological systems as are contained within the political boundaries of California, which includes the highest and lowest elevations of the lower 48 states.

Most of the regional chapters are written by scientists with considerable local experience in their assigned ecoregion, and many excellent narratives are included in the book. The Klamath Mountains chapter (by Carl Skinner) provides a well-honed discussion of how fire behavior and fire regime have interacted with the physical landscape template, with respect to the distinctly convoluted topography and famously complex geology of those particular mountains. The Northeastern Plateaus chapter (by Gregg Riegel), describing California's portion of the Great Basin, includes a nuanced description of fire ecology in the sagebrush steppe zone. There are useful discussions of interactions among fire regime, plant community succession, and directional vegetation shifts such as have been prevalent in the western United States over the past century. Many of the regional chapters, and especially the Sierra Nevada chapter (by Jan van Wagtendonk), contribute discussions of historical human influences including those prior to Euro-American settlement, and place current fire and forest management issues within this long-term context. A recurring theme of the regional chapters is the importance of fire exclusion for altering contemporary fire regime and ecological processes. As stated in the Sierra Nevada bioregional chapter (p. 290), "The question becomes how to restore natural fire regimes without adversely affecting at-risk species and their habitats... These species evolved with fire and the answer must include fire." However, bioregions that are characterized by chaparral vegetation at lower elevations (South Coast, portions of the Central Coast) now experience more frequent fires than historically, as a result of human ignitions and urbanization.

Several of the bioregional chapters (North Coast, Southern Cascades, Central Valley) paint a picture of Native American burning that, while quite plausible, is supported by a paucity of primary literature sources. The strength of evidence supporting native burning could be presented in a less anecdotal fashion, and the authors could have made clearer that while aboriginal fire may have been critical for shaping vegetation structure in certain vegetation types, it was likely of low importance for other types, such as those in less productive, high-elevation areas.

The final section of the book (Chapters 17–24) addresses fire management issues that range from the over-arching to the very practical. The important questions are not neglected. How can we describe a historic range of variability, or meaningful reference conditions for restoration, in the context of Native American fire use? How can we incorporate fire use in our management planning and still protect people and their resources given the great increases in population over the past decades? These chapters emphasize fire effects and discuss the negative effects of fire use that can occur with less than perfect planning, with respect to aquatic systems, air quality, exotic plant invasions, and habitat for at-risk species.

Chapter 17, contributed by Kat Anderson, presents an exhaustive yet balanced description of Native American fire use. The chapter describes the continuum of influences across this

large and heterogeneous state, including areas of low influence due to low population (serpentine and subalpine environments) as well as areas where Native American fire management was likely high because of high population densities and cultural fire use (northwest coastal prairies region).

In Chapter 18, Scott Stephens and Neil Sugihara provide a thorough background into the historical events and cultural influences leading to the triumph of fire suppression policies over a "light burning" paradigm for forestry in the western U.S. The discussion eventually winds its way to contemporary fire management including new manifestations of the fire use paradigm, leading to today's changing perspectives and policy shifts. Husari et al. (Chapter 19) continue with this theme in their chapter on fire and fuel management, describing the shift in management focus and policy from fire control to fuel management. As for most of the other chapters in this book, there is a laudable effort to place where we are today in the context of past management practices and historical influences.

Chapters 20–23 describe fire management issues regarding aquatic resources, air quality, invasive plant species and species of conservation concern. The first of these chapters (watershed resources, contributed by Andrea Thode and others) is brief but well-focused, and performs the amazing feat of not repeating material from earlier chapters. There are useful summary tables contrasting various watershed rehabilitation methods. Fire is treated as an integral watershed process and there is a balanced discussion of controversial ideas pertaining to active management of forested riparian zones. There is useful emphasis on linking watershed restoration and fire management activities. The air quality chapter (by Suraj Ahuja) provides an informative summary of fire effects on air quality and how fire and fuels management are constrained by air quality regulations. The invasive plant species chapter (by Robert Klinger) elucidates the complex, two-way interactions between fire regime and exotic plants. Missing from this chapter is mention of the interaction between fire and invasive forest pathogens such as Sudden Oak Death.

It is unfortunate that the management section of the book lacks a chapter on wildland fire use in undeveloped areas. Over 14 million acres in California are managed as wilderness and how to manage wildland fire in these areas has become an issue of prime importance. The management section chapters instead focus almost exclusively on issues of the wildland-urban interface and active forest and fire management in traditionally managed forests.

Neil Sugihara takes the lead in summarizing all three sections of the book (Chapter 24). This final chapter is essentially a call for society to act now to restore fire as an ecosystem process, even when knowledge is incomplete and ecosystem alterations and discontinuities prevent a return to historical conditions. We need to manage fuels and fire regimes so as to counter the ecosystem changes and negative biodiversity effects resulting from a century of fire exclusion. However, certain bioregions and vegetation zones (coastal chaparral, subalpine forests) have not experienced fire exclusion and need to be managed differently, as pointed out by Jon Keeley in his South Coast chapter. Coastal chaparral now burns more frequently and later in the year than prior to settlement, but the actual area burned is within a historic range of variability because suppression efforts keep most fires small. Fire management and landscape restoration must be adapted to the particular bioregional setting, and this book provides the regionally specific information required to support such efforts.

The book's emphasis on providing a compendium of the current state of knowledge regarding California fire ecology can be seen as a limitation as well as a strength, in that it summarizes what we know rather than suggests directions for future research. Some of the chapters could have been reined in a little more with respect to repetitive, extraneous detail. The book has been closely edited for consistency in organization, but not necessarily for content and brevity. *Fire in California's Ecosystems* is not intended to be read cover to cover, but rather will serve as a reference work. The persistent reader will emerge with new information and perspectives gained from diverse scientists and forest managers who have spent considerable portions of their careers working with the topics and geographic areas about which they have written.

This comprehensive, multifaceted work will be informative for fire scientists and managers at all levels. It interweaves biological, physical, cultural and operational aspects of fire science through a collection of contributed chapters. The usefulness of the work clearly transcends the state of California. *Fire in California's Ecosystems* is one of the more valuable fire ecology books to come out in a long time, and it has something to offer nearly everyone: research scientists and university instructors, fire and forest managers, students of various ecological, environmental and natural resource disciplines, and the interested citizen. It may not make for good "light reading" at the beach, but is a resource worth having on your bookshelf.

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Weeds of California and Other Western States. By JOSEPH M. DITOMASO and EVELYN A. HEALY. 2007. University of California Agriculture and Natural Resources Publication 3488, 6701 San Pablo Avenue, Oakland, CA 94608-1239. Two volumes, 1808 pp. plus CD with photographs Softcover. $100.00. ISBN 1-879906-69-4.

In California, this may be the most important book since the publication of *The Jepson Manual* in 1993. There are three compelling reasons for this. First, unlike several local floras that have been published in the meantime, this treatment covers the whole state of California. Second, because California is one of the three U.S. states with the highest number of naturalized plant species, and because a substantial proportion of weeds are naturalized species, this component of the flora deserves a special attention. Third, the last comprehensive book on weeds of California was published 56 yr ago (Robbins et al. 1951; actually, 66 yr ago, because the 1951 edition was only minor modification of the first edition from 1941).

Weeds of California (Robbins et al. 1951) covered 693 species, 437 (63%) non-native and 256 (37%) native. Based on my counting, the main text of the DiTomaso and Healy's volumes deals with 677 (83%) non-native and ca. 140 (17%) native weedy species. Moreover, 714 additional, rarely naturalized or casual non-native species are listed in the Appendix. Out of ca. 817 species treated in the main text, 737 are illustrated by at least one color photograph, most of them by several photos of mature plants, seeds, and seedlings. There is probably no other country in the world with a so well illustrated weed manual. Plant identification is facilitated by tables summarizing important characters of species within genera or groups of closely related genera (e.g., ice plants and relatives, *Amaranthus*, *Bidens*, *Brassica* + *Hirschfeldia* + *Sinapis*, *Centaurea*, *Euphorbia*, etc.). Thirteen shortcut identification tables for groups that share similar, unusual, or relatively uncommon characters (plants with prickles, spines, or thorns, plants with palmately compound leaves, plants with square stems, etc.) are also quite helpful. Moreover, two grass identification keys are provided: a key based on all characters and a key based on vegetative characters only. The main body of the volumes contains weed descriptions that are presented in alphabetic order according to family, genus, and species. The text includes not only detailed morphological descriptions of the taxa, but also information on distribution, habitat, reproduction, phenology, and management options. All morphological terms used in the text are explained in an illustrated glossary.

Regarding the main text and illustrations, I have only a very few comments. Among over 2000 photographs, I found only one mistake: the photograph of *Trifolium angustifolium* on p. 811 is definitely not a picture of this species, but of a different clover. *Polycarpum* (pp. 573–575) should be spelled *Polycarpon*. A new non-native *Amaranthus* – *A. viridis* L. was recognized in California recently (Daniel 2005). Besides *Hedera helix* L. and *H. canariensis* Willd., plants derived from *H. hibernica* (Kircher) Bean seem to be quite common (Clarke et al. 2006). The correct name for spotted knapweed seems to be *Centaurea stoebe* L. subsp. *micranthos* (S.G. Gmelin ex Gugler) Hayek. Authors' note that Californian spotted knapweeds may be primarily classified as C. vallesiaca (DC.) Jord., species known from France, Italy and Switzerland, would deserve some elaboration. The fact that most of the *Raphanus* plants in California are hybrids (Panetsos and Baker 1967) is not mentioned. Good photos or drawings of lemma tips would help to make a distinction between *Avena barbata* and *A. fatua*. There are 31 species in the main text that were not included in *The Jepson Manual* (23 of them were recently reported by Hrusa et al. 2002). This is not always clearly indicated. Four species included in the main text are not present in California (*Brassica elongata*, *Hieracium caespitosum*, *Salsola collina*, and *Vinca minor*). This can be justified because some of them could be found in California in the foreseeable future. Including more pictures of species that are common and difficult in other mediterranean areas and are still rare or absent in California would make a weed manual even more helpful in early detection of potentially pestiferous invaders. Examples include *Atriplex numularia* Lindl., *Galega officinalis* L., *Leptospermum laevigatum* (Gaertn.) F. Muell., *Melia azedarach* L., *Parasierianthes* (*Albizia*) *lophantha* (Willd.) Nielsen, *Rosa moschata* J. Herrm (Henderson 2001; Mathei 1995). While the number of native weeds was definitely somewhat inflated in Robbins et al. (1951), several important native weeds are missing here. This is particularly true for weeds in forest plantations (see e.g., Tab. 2–3 in Walstad and Kuch 1987).

There are 722 non-native taxa listed in the Appendix. After excluding subspecific taxa and two species that were already treated in the main text, we are left with 714 alien species. Two of them are here by a mistake and should be deleted (*Acer saccharum* and *Genista aetnensis*). Most of the species (435) were already in *The Jepson Manual* (Hickman 1993). Among remaining 277 species (most of them are marked by asterisk), 261 were presented in Hrusa et al. (2002). Unfortunately, this was not acknowledged and neither was the origin of the information for the remaining 16 species. Nevertheless, one would expect that adding 673 non-native species from the main text to 712 non-native species from the

Appendix, the total of 1385 should equal the number naturalized and casual plant species in California. However, there are three problems here. First, some non-native species that were included in DiTomaso and Healy's (2003) previous book on wetland weeds appeared in the main text or in the Appendix, but some did not (e.g., *Aeschynomene rudis*, *Heteranthera limosa*, *Limnobium laevigatum*, *Najas graminea*, *Potamogeton crispus*, *Rotala indica*). Second, some established non-native species that are in *The Jepson Manual* are not in this Appendix (e.g., *Cnicus benedictus*, *Chenopodium strictum*, *Lathyrus sphaericus*, *Mollugo cerviana*, *Plantago virginica*, *Rumex orbiculatus*). Third, several species that were reported in Hrusa et al. (2002) are also missing in the Appendix (including *Asclepias fruticosa*, *Chrysanthemum balsamita*, *Silene pseudatocion*, *Ipomea quamoclit*, *Ephedra distachya*, *Cinnamonum camphora*, *Papaver capreolata*, *Passiflora mixta*). Therefore, we may conclude that we have ca. 1400 more or less established non-native plant species in California. Nobody will ever get the definite number. Some species probably do not grow in California any more (e.g., *Agrostema githago*) and some were probably eradicated (e.g., *Carthamus leucocaulos*, *Cuscuta reflexa*, *Grindelia papposa*, *Peganum harmala*, *Salvia virgata*, *Solanum cardiophyllum*, *Tagetes minuta*). Some species should not be counted because they are only persisting (e.g., *Jugnans regia*) or grow only in greenhouses (e.g., *Muntingia calabura*). On the other hand, new species are arriving (Jepson Flora Project 2007), and some "native" species – *Phalaris arundinacea*, *Spirodela* (*Landoltia*) *punctata* - are being recognized as exotics (Jacono 2002; Lavergne and Molofsky 2007).

The weakest part of this manual is the Bibliography (pp. 1680–1740). It is only slightly better than the one that was in DiTomaso and Healy's (2003) previous book that I reviewed for Madroño in 2003. First, General References: There are several obscure references here, but relevant basic publications on Californian weeds or invasive plants in general are missing (e.g., Baker 1962, 1974, 1986, 1995; Inerjit 2005; Myers and Bazely 2003; Pyšek et al. 2004; Randall et al. 1998; Rejmánek and Pitcairn 2002; Walstad and Kuch 1987; Weber 2003). Second, as for individual genera, references are far from balanced: e.g., 12 references to *Kyllinga* and 29 to *Taeniatherum*, but none to *Amsinckia*, *Bidens*, *Foeniculum*, *Hypericum*, *Raphanus*, *Viscum*, *Xanthium*, etc. References to *Anthemis cotula* are under *Cotula*. Gerlach's excellent studies of *Centaurea solstitialis* in California are missing (Gerlach and Rice 2003; Gerlach 2004). Ten, mostly Australian, references are under *Chondrilla*, but the most important reference to its biocontrol in California (Supkoff et al. 1988) is not listed. Again, many bizarre references (e.g., "Wild Flowers of Mount Olympus") are here, but essential references to such Californian weeds like *Carpobrotus chilensis*, *Mesembryanthemum crystallinum*, *Prosopis*, *Salsola*, or *Toxicodendron diversilobum* (Bicknell and Mackey 1998; Vivrette and Muller 1977; Holland 1987; Gaskina et al. 2006; Ryan and Ayers 2000; Gartner 1991a, b) are missing. A reference to the bibliography of European biological floras (Poschod et al. 1996) would be helpful.

Obviously, while the main body of this treatment is undoubtedly a great achievement, the value of the Appendix and Bibliography is rather questionable. My recommendation for the potential next edition of this manual would be to make it more economical (e.g., some redundant photographs could be deleted, pictures of seeds for all species in each genus could be combined into one), delete the Appendix and Bibliography (more professional version could be available online), and publish everything in one user-friendly volume. Recently published Flora of the Santa Ana River (Clarke et al. 2007) can serve as an example of how this could be done.

In spite of my criticism, this is a monumental piece of work. Even with digital cameras you have to find the plants first. The authors found almost all of them!

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American Perceptions of Immigrant and Invasive Species: Strangers on the Land. By PETER COATES. 2007. University of California Press, Berkeley, CA. 266 pp. Hardcover. $39.95. ISBN 13: 978-0-520-24930-1.

One of the defining characteristics of humans is their tendency to want to manage nature so that it meets their perceptions of "how things should be." Ecologically, this has been translated in numerous ways, from wildlife management practices that once promoted intense predator control to notions of restoring landscapes to "pre-European conditions." Of course, these perceptions are not universally accepted at any given point in time, and perhaps more important the prevailing opinion (i.e., conventional wisdom) often shifts over time. Hence, we now see the reintroduction of predators into areas they were once extirpated from, and the gradual realization by restoration practitioners that trying to convert an ecosystem to an arbitrary point in time (and then keeping it there) is fraught with both conceptual and practical problems. In *American Perceptions of Immigrant and Invasive Species*, Peter Coates, an environmental historian at the University of Bristol, uses historical and contemporary case studies to analyze views on nonnative species in the United States over the last

two centuries. But rather than limiting his analysis to an ecological viewpoint, Coates poses the question of whether our attitudes towards non-native plants and animals have simply been a reflection of the prevailing way American society thinks about immigrants in general, or whether the two issues are essentially independent of one another. By doing this, he places the issue of biological invasions in a broader context of social and cultural perceptions than they are typically found. One of the tangible achievements of Coates book is that it clearly shows that perceptions of "how things should be" depends on where and when you are standing in a certain place, a lesson that scientists and conservation practitioners too frequently forget.

In many ways, *American Perceptions of Immigrant and Invasive Species* is an extension of Coates' earlier book *Nature: Western Attitudes Since Ancient Times*, (Blackwell Publishers 1998). Coates employs the same approach here as he did in *Nature*. Using history as his pathway, he describes the development of perceptions towards natural phenomena both within and across given periods of times, with the path ultimately ending in our own contemporary era. Though he does not ignore their philosophical underpinnings, Coates is an empiricist at heart and is more interested in the cultural manifestations and social outcomes of our perceptions than their logic or intellectual merit. Indeed, Coates uses their contradictions to illuminate from where these perceptions arise and how they become part of our collective psyche. In the case of *American Perceptions of Immigrant and Invasive Species*, he has simply narrowed his scope from broad views of nature to specific views on a particular, albeit highly charged, part of nature.

Coates structures the five-chaptered book in two ways. One is used to develop the general themes that cut across the individual chapters and unite the case studies. The other is the approach he uses within the individual chapters. Coates presents an initial overview of the specific topic in the opening section of each chapter, including its issues, time period, and major players. He then uses the remainder of the chapter to dive into the details. This allows Coates to deepen each case study with scholarly particulars, but by maintaining a coherent thread that runs throughout the book the general themes are never lost in minutiae.

In the introductory chapter, Coates explains the importance of what is in a name, depicts the tendency of humans to transfer human qualities to species and species qualities to humans, and makes initial comparisons between opinions towards biological invasions and human immigration. Perhaps most important, he sets the stage for the stark contrast between the opinions of those who adhere to the philosophy that native born species, or individual humans, are best suited for an area (the "nativist" philosophy) and those who feel that local qualities are vastly improved with infusions from other areas (the "cosmopolitanist" philosophy). In one way or another, it is the conflict between the nativists and the cosmopolitanists that plays out across the next four chapters. Chapters 2–4 are largely on historical events. They describe the contributing factors and often heated debates surrounding the introduction and spread of the house sparrow, (and to a lesser degree the starling; Chapter 2), agricultural crops and their pests and pathogens (Chapter 3), and tree-of-heaven and eucalyptus (Chapter 4). In Chapter 5, Coates returns to his broader themes by focusing on the controversies surrounding human immigrants and biological invasions in our era. My guess is most readers of the book will find Chapter 5, as well as the latter part of Chapter 4, the most accessible because the case studies are largely contemporary. However, it is in Chapter 3 where the debate between the nativist and the cosmopolitanist schools best informs us of where our deeper perceptions, and inherently contradictory attitudes, towards non-native species can lead us.

Coates is a good enough writer and thorough enough thinker that, overall, the book is a lively and absorbing read. Having said that, it is important to point out that while it is not technical by any stretch of the imagination, the book is nevertheless an academic publication that is dense in detail. Most of the time the detail adds color and depth to the narrative, but in some places it can make it difficult to follow, especially when trying to link some of the more obscure players to specific events or ideas attributed to them several pages (or even chapters) back. Though this makes the book less accessible as popular reading, the tradeoff is that it is an intelligent and scholarly work that never wanders into the often sensationalist and shallow writing not uncommonly found in non-technical pieces on both non-native species and immigration. Although Coates has his opinions, they tend to illuminate rather than consciously skew the issues. His insights and subject matter remain vibrant, and he is adept at drawing the details together into a coherent whole at the end of each chapter.

The book does have one flaw. Coates seems to have tried to make a compromise between the depth and breadth of the book (something that also characterized *Nature*). He did a very admirable job mining the depths of his three case studies; of the books 256 pages, 189 are devoted to narrative and the rest to footnotes. But what was gained in detail resulted in a sacrifice in breadth. Drawing general conclusions from the three main case studies is difficult because they are not entirely representative of the way other

species introductions in North America have played out. The book would have had greater breadth had Coates included one or two additional case studies that broadened the debate. He undoubtedly picked his case studies strategically because they provided the links he was seeking between invasive species and immigration, especially for examining these links across time periods and shifting social and cultural values. In some ways though, the stories of house sparrows and starlings and eucalyptus and many agricultural crops are old news. They have been well-documented, and the stories all play out more or less in the same way. Overlooked or only given scant mention are stories of other introduced non-native species that have been less contentious, or, up until modern times, considered to be of benefit to humans. This includes game animals such as ring-necked pheasants, chukar, brown trout, and wild boar, and trees such as the European olive and fig. The question of when a species ceases to become native and becomes an invasive and harmful non-native is a critical one and is almost entirely ignored. Mountain goats in Olympic National Park, horses in parts of the arid and semi-arid western United States, some fish species (e.g., rainbow and brook trout), and plants such as yellow bush lupine are either native to some regions of the country, a state, or a bioregion, but not others, or they were native to the continent in relatively recent times. These are provocative examples of the capricious way humans continue to decide what belongs in an ecosystem and what does not, and could have provided broader insights into our perceptions of non-native species introductions. As compelling a book as *American Perceptions of Immigrant and Invasive Species* is, it probably would have been even more so if Coates had picked some of these lesser known but equally telling examples as case studies.

Nevertheless, while the stories of house sparrows and starlings and eucalyptus have been fodder for discussion for decades, many people involved in research and management of invasive non-native species have forgotten that their concerns are not new ones. It is even debatable whether the topic is any more heated or complex now than it was a century ago. The singular strength of this book is that it highlights that, in many ways, the issues and controversies that surround species introductions have been ongoing for centuries, and in many ways they have not changed substantially. They have only been translated into the value sets, language, and perceptions unique to our time. For this reason alone, the book is a highly informative work that provides useful insights not just for people doing work on non-native species, but ecologists and conservationists in general.

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